


## ТЕХНОЛОГІЯ ВИРОБНИЦТВА І ПЕРЕРОБКИ ПРОДУКЦІЇ ТВАРИНИЦТВА

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**Linear type traits that characterize body development as the predictors of lifetime of Ukrainian Black-and-White dairy and Holstein cows**Khmelnichyi L. , Samokhina E. , Khmelnichyi S. , Karpenko B. 

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Хмельничий Л.М., Самохіна Є.А., Хмельничий С.Л., Карпенко Б.М. Лінійні ознаки типу, які характеризують розвиток тулуба - предиктори довголіття корів української чорно-рябої молочної та голштинської порід. Збірник наукових праць «Технологія виробництва і переробки продукції тваринництва», 2023. № 1. С. 19–28.

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The researches were conducted in the aspect of studying the problem of dairy cows lifetime depending on the linear traits assessment of the conformation type. By the linear classification method were estimated firstborn cows of the Ukrainian Black-and-White dairy (UBWD) and Holstein (H) breeds. Descriptive traits of the conformation that characterize the overall body structure were studied: chest width, body depth, angularity, body condition, rear width and position. According to the research results, the relative variability of the descriptive type traits assessment with cow's lifetime was determined. The relative variability of chest width and cow's lifetime was curvilinear. Cows for chest width assessment of 4–7 score had a higher lifespan with a variability of 2704–2844 (UBWD) and 2688–2789 (H) days. The highest lifetime was in animals with an assessment for body depth development of 6–9 score with an unreliable predominance of Ukrainian Black-and-White dairy breed cows, with the highest grades of both breeds 2824 (UBWD) and 2802 (H) days with an assessment of 9 score. Animals with an optimal angularity estimation of 5 score differed, lived the longest – 2842 (UBWD) and 2828 (H) days, while with increasing and decreasing score for this trait, the number of lifetime days of cows declined. According to the rump width assessment, lifespan was highest in cows with a 9 score – 2766 days (UBWD) and 2832 days (H). Cows of UBWD with the highest assessment for this body part development of 9 score were used on 592 ( $P < 0.001$ ), and Holstein on 708 ( $P < 0.001$ ) days longer compared to animals with 1 score. The maximum lifetime of animals with an average assessment for body condition of 5 score was 2842 (UBWD) and 2774 (H) days. Cows with body condition score below average lived and were used in the herd much longer than with a higher one. The degree of relationship variability between the assessment of these traits and the lifetime of animals depended on the specific body part.

**Key words:** Ukrainian Black-and-White dairy breed, Holstein, linear type traits, lifetime.

**Problem statement and analysis of recent research.** Dairy cattle breeding is one of the leading branches of animal husbandry, which explained by the wide distribution of cattle in different natural and economic zones and the high share of milk and beef in the total mass of livestock products. In recent years, significant progress has been made in the development of scientific foundations and practical methods for improving production tech-

nology in dairy cattle breeding, realizing the genetic potential of animal productivity, improving their technological qualities, and obtaining high-quality products. Created Ukrainian dairy breeds, when providing optimal conditions for feeding and care, are capable of high productivity that was proven by individual enterprises for their breeding.

Against the background of increasing the milk productivity of the created breeds, a problem

arose, which consisted in reducing the duration of their use. The terms of the productive longevity of dairy cows become one of the main criteria for the efficiency and profitability of dairy farming. Calculations show that if the average duration of use of cows will be less than 2.5 lactations, then the mother cows will begin to drop out from the herd before their daughters give birth.

Since the modern dairy breeds of Ukraine were created by methods of reproductive crossing, they are currently characterized by significant diversity in terms of their genotypic composition.

In farms where the conditions for feeding and keeping livestock are still somewhat less than optimal, animals received from the breeding of hybrid genotypes "in itself", thanks to their unique adaptive qualities, could differ in terms of longevity from (high-blooded) purebred breeds obtained from absorptive crossbreeding. Since the latter were characterized by much higher fastidiousness to environmental conditions.

In general, the longevity of cows is a complex holistic trait determined by a group of both hereditary and paratypical factors. The solution of the problem of at the expense of hereditary factors became more complicated due to the low longevity heritability of the traits that characterize it. World studies have reported that in the selection of dairy cattle, the traits of longevity were characterized by low heritability, although no one doubts their hereditary conditioning. According to the authors [33], the degree of heritability of lifespan was 0.01–0.36, depending on the breed and research method. Other sources of information report that the heritability of lifetime of Holstein cows varied from 0.05 to 0.07 [37], in animals of the Simmental breed of the Czech Republic heritability coefficients ranged from 0.04 to 0.05 [40], and Holstein cows from 0.03 to 0.05 [41].

In the study of the conditional share influence of Holstein blood on cow's longevity traits of the Holsteinized intrabreed type of Ukrainian Red dairy breed [5], a decrease in the economic use duration with an increase in the heredity share of improving breed was established. Which in crossbreeds with 25.1–50.0% blood was 1803 days, while in animals with 50.1–75.0% blood – 1672, and with blood 75.1 and more – 1710 days.

In the herd of the Ukrainian Red dairy breed in the breeding farm "Partizan", on a population of 275 cows, a relatively higher and reliable (up to  $P < 0.001$ ) relationship with the effectiveness of lifetime use was noted on indicators of blood for improving breeds (-44.2...40.7%), attachment density of the front (23.0...26.8%) and rear (23.2...30.5%) udder parts and the final score by type of body structure (8.7...21.7%) [4].

According to the research results on the influence of Holstein breed heredity on the traits of cows longevity of the Ukrainian Black-and-White dairy breed, it was established that in crossbred animals, daughters of the breeding bull Leros 909528547, with conditional Holstein blood of 62.6–75.0%, the lifespan was in an average of 2159 days, and in crossbred animals with 87.6–93.75% blood – 1981 days. In the daughters of the sire V. Astronomer 2160438, these indicators were 3271 and 2098 days, the difference of 1173 days was reliable at  $P < 0.01$ , respectively [29].

Based on the information on 2517 cows of the Black-and-White breed and crossbreeds with the Holstein, the lifetime was studied, which amounted to  $2202 \pm 104.9$  days in cows crossbred by the Holstein (50.0 H "in itself"),  $2358 \pm 26.5$  (50.0 % H of crossbreeding),  $1757 \pm 144.7$  (75.0 H "in itself") and  $2032 \pm 26.8$  days (75.0% H of crossing). That is, with the increase in the heredity of Holstein breed, the lifetime of crossbred cows decreased, and cows of crossbred genotypes from breeding "in itself" were inferior by this indicator to animals obtained in the variant of absorptive crossbreeding [14].

According to the research of seven experimental groups of crossbred cows of Ukrainian Red-and-White dairy breed, taking into account the conditional blood of Holstein breed (I group 25.0%, II – 37.5; III – 50.0; IV – 62.5; V – 75.0; VI – 87.5; and VII – 93.75%) the highest lifetime of cows with 25.0% Holstein blood was established, which amounted to 2762 days using animals of 5.3 lactations. In cows with Holstein heredity of 93.75%, similar indicators were 1989 days and 3.2 lactations, respectively, a difference of 773 days with high reliability ( $P < 0.001$ ).

About the genetic component in the overall phenotypic variability of the traits of duration of life and productive longevity was also reported by other Ukrainian scientists [7, 16, 20, 24, 26, 27].

Solving the problem of dairy cattle longevity was helped by the selection of animals on the traits of conformation type, since the motivation of this measure was based on the existence of correlative variability between body parts of the conformation and indicators of cow's use duration [10, 25, 30, 35, 37, 40, 41].

According to studies on determining the relationship between the udder linear traits and cows lifetime assessment of the Ukrainian Black-and-White dairy breed, it was established that cows with higher scores for condition of the morphological udder traits development – the strength of front parts attachment (8 score), height of the rear parts attachment (8 score), expressiveness of the central ligament (9 score) and udder depth

(9 score), have a significant advantage in terms of lifetime, exceeding animals with the lowest score by 762–970 days. By the assessment of linear body part – front teats placement, cows with an assessment of 5 score (2337 days) were used for the longest time in the farm's herd [23].

When studying the descriptive linear traits that characterize the limbs condition of cows of the Ukrainian Black-and-White dairy breed, it was established that the lifetime of animals with an assessment of the hock joint angle at 5 and 6 score compared to groups of animals with an estimation of 1 and 9 score exceeded for 592 and 333 days, respectively. Studies have proven the positive influence of the hind limbs posture, foot angle and locomotion on the lifetime of animals. Groups of animals with an estimate of 9 score exceeded animals with an estimate of 1 score in lifespan by 971; 1094 and 1127 days at a highly reliable level, respectively [19].

According to the linear estimation of Jersey cows, significant moderate to strong positive genetic correlations were established between most udder traits and the functional life of cows in the herd (from 0.23 to 0.63) [31]. The authors [32] based on studies of Mexican Holsteins suggest including five linear traits (chest width, teat length, central ligament, texture and udder depth), which were positively correlated with the length of productive life, as indirect predictors of longevity.

The duration of use of brown Swiss cows was influenced by the existence of moderate genetic correlations between the productive life and the hind limbs posture ( $r = 0.35$ ) and foot angle ( $r = 0.25$ ) [39].

The authors [36] are convinced that indirect genetic selection for the traits of udder depth, placement of rear teats, udder texture, bone quality, front udder attachment, body depth and chest width can lead to a correlated increase by the longevity of Holstein cows in tropical conditions.

It should be noted that in modern conditions of intensive milk production technologies, the longevity indicators of dairy cows occupy an important link in the economic chain of the livestock industry development, since the profitability of its management largely depended on them [8, 14]. Due to its high economic importance, national dairy associations have registered longevity as a breeding trait [15, 38].

The introduction of the method of linear classification into the selection process of improving dairy breeds of Ukraine [28] made it possible to reveal the desired development of those linear traits on which the lifetime of animals depended, in order to consider them in the selection process.

**Materials and methods of research.** The research was carried out in the herd of the company "Ukrlandfarming" PE "Burynske" of the Pidlisniv branch in the Sumy district for the breeding of Ukrainian Black-and-White dairy ( $n=278$ ) and Holstein ( $n=293$ ) breeds. The conformation type of firstborn cows was assessed using the linear classification method [28] by the latest ICAR recommendations [11] at the age of 2–4 months after calving. Experimental indicators were processed by the methods of biometric statistics on a PC by the formulas given of O.G. Blyznychenko [13].

**The aim of the research.** The purpose of our research was to study the dependence of the lifetime of Ukrainian Black-and-White dairy cows (UBWD) and Holstein (H) breeds on the assessment level of linear traits that characterize their body structure.

**Research results and discussion.** By the results of the linear classification of descriptive traits of the conformation, which characterize the overall body structure of the firstborn cows of experimental breeds in the controlled herd: chest width, body depth, angularity, body condition, rump position and width, the corresponding relative variability between these traits assessment and the animals lifetime was established.

The strength of dairy cows characterized by the chest width, as it indicates the chest volume, which houses the vital organs of respiration and blood circulation. Animals with a well-developed chest have a strong type of constitution. The results of assessment of the chest width influence on the cow's lifetime (Fig. 1) indicate a relative curvilinear relationship between these traits, which was characteristic of both breeds. Animals with a chest width assessment in 4-7 score had a higher lifespan with a variability of 2704–2844 days for Ukrainian Black-and-White dairy cows and 2,688–2,789 days for Holstein breeds.

With an increase in the assessment from the average value of 5 to 9 score, the lifetime of UBWD cows decreased by 385 days ( $P<0.01$ ), and a decrease in the assessment to 1 score shortened the life by 455 days ( $P<0.001$ ). The average assessment in 5 score for cows of the Holstein breed provided the highest lifespan (2789 days). The difference between the assessment in 5 and 9 score was 400 days ( $P<0.001$ ), and in comparison with 1 score – 487 days ( $P<0.001$ ).

The interbreed statistically unconfirmed difference between the type trait of chest width and lifetime within the 9-score descriptive linear assessment was 16–79 days in favor of cows of the Ukrainian Black-and-White dairy breed.

The body development of dairy cows in depth characterizes the appropriate condition of the

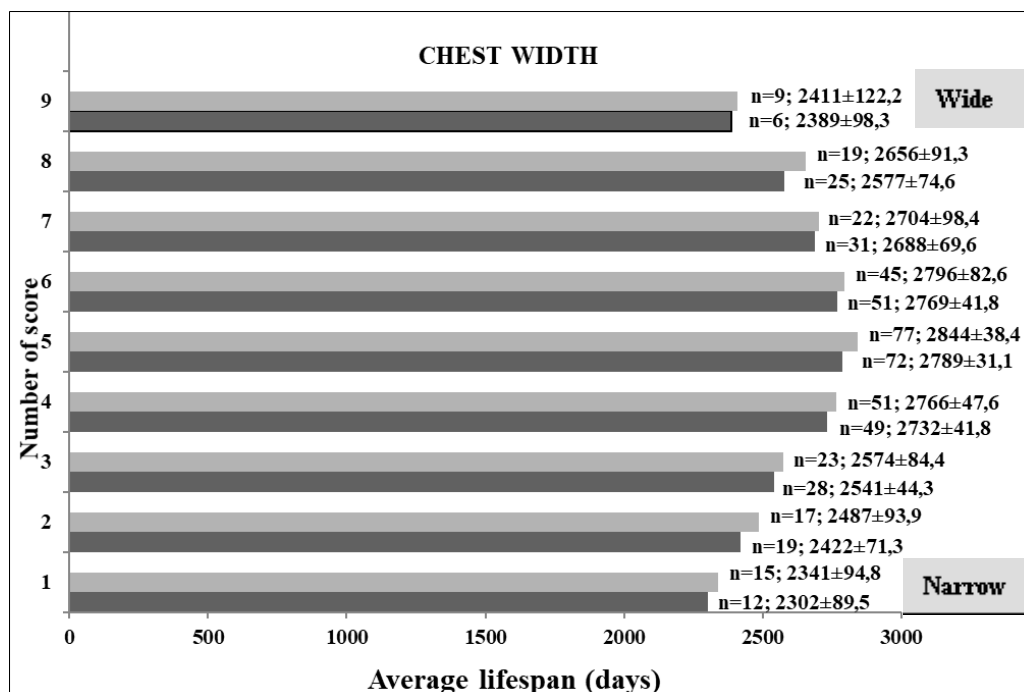
digestive tract. Deep-bodied cows are able to consume significantly more roughage and convert it into milk production. This conclusion was confirmed by the results of studies that established high and reliable correlation coefficients between body depth and milk yield of cows during the first lactation [8, 18].

The results of studies on the determination of the correlative variability of the score assessment of the descriptive type trait "body depth" and the lifetime of cows in the controlled breeds indicate that the longest lifespan was inherent in animals with body part development of 6–9 score. An unreliable predominance was in cows of the Ukrainian Black-and-White dairy breed with the highest indicators in both breeds of 2824 (UBWD) and 2802 (H) days with an assessment in 9 score (Fig. 2). About the influence of scores for a certain level of development of descriptive linear traits in overall, and body depth in particular, on lifetime was evidenced by the correlative reliable difference between an assessment in 1 score and of 5 to 9 score. Which was for UBW cows from 242 (P<0.05) to 422 (P<0.001) days and for Holstein cows from 173 (unreliable) to 388 (P<0.001) days.

The importance of the next linear trait – angularity, in the breeding of dairy cattle was confirmed by studies that established the existence

of a highly reliable positive correlation between this trait and milk yield during the first lactation [8, 18]. Similarly, the angularity is in a positively correlated variability with the lifetime of dairy cows of Ukraine and the world [9, 21, 22, 31, 32, 34, 39].

According to the data of our research, cows of the UBW and Holstein breeds with excessive angularity and the longest lifetime (2812 and 2846 days) were estimated by higher score, which gradually downgraded with a decrease in the assessment for this trait (Fig. 3). Animals of both breeds with the desired development of this trait, assessed at 9 score, exceeded the groups of animals with an assessment of 1–8 score at 28–547 (UBWD) and 38–513 (H) days from an unreliable difference to a highly reliable one. In UBW cows, a statistically significant difference was found starting in the comparison of the group of animals with an assessment of 9 score to the group assessed in 5 score, which was 134 days (P<0.05). A significant intergroup difference among Holstein cows began when comparing groups with estimates of 9 and 6 score, which was 144 days (P<0.01). The interbreed difference for this type trait within the 9-score scale was in favor of Holstein cows and amounted to a variability of 28–87 days, but it was not statistically reliable.



Note: here and later – ■ – Ukrainian Black-and-White dairy breed;  
 ■ – Holstein breed.

Fig. 1. Correlative variability of the score assessment for descriptive type trait "chest depth" and lifespan of cows in controlled breeds.

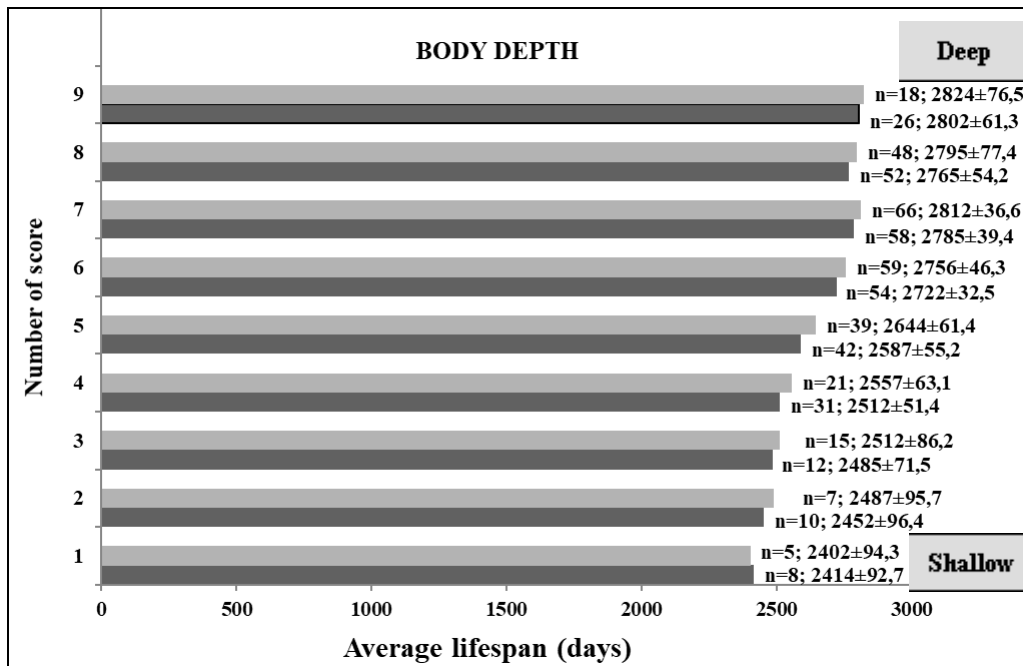


Fig. 2. Correlative variability of the score assessment for descriptive type trait "body depth" and lifespan of cows in controlled breeds.

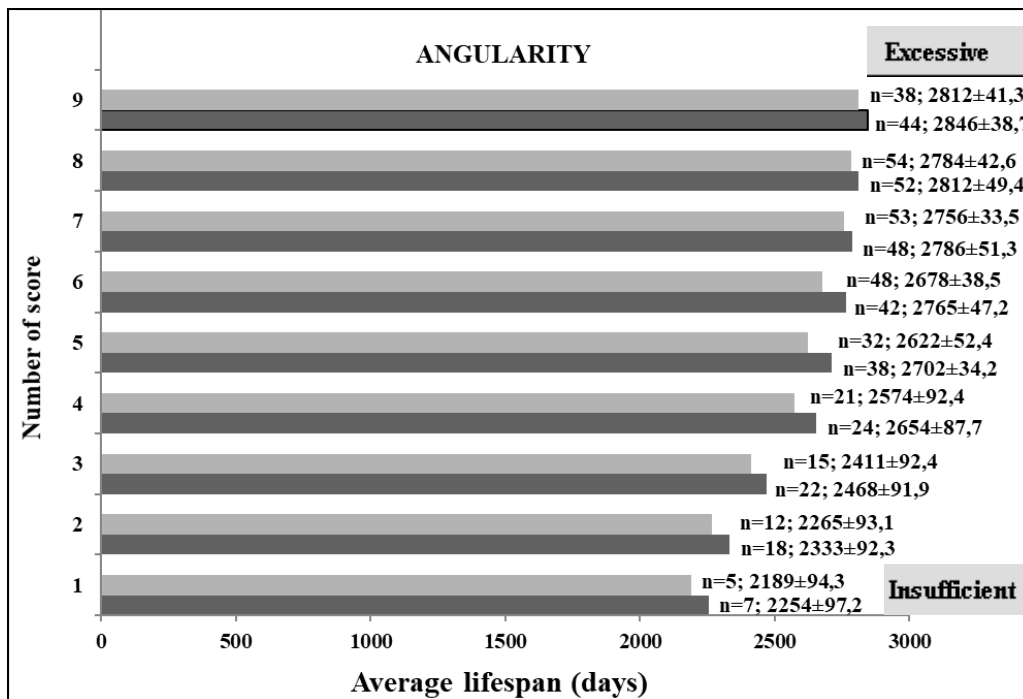


Fig. 3. Correlative variability of the score assessment for descriptive type trait "angularity" and lifespan of cows in controlled breeds.

The linear descriptive trait "rear posture" takes into account the degree of slope or raise of the rump along a conditionally drawn line at the level of the upper points of the hook bones and ischial humps. The optimal level of slope between the extreme points 2–4 cm was a desirable expression of this type trait estimated at 5 score. The deviations in the direction of the rump posture assessment to 1 (raise) or 9 score (slope) will be significant body part disadvantages. The rear posture greatly affected on the reproductive capacity of animals. If the rump is very high, there is a risk of the birth canal infection. According to our research results, the relationship between the estimation of this trait condition and the lifetime of cows characterized by curvilinear correlative variability. Animals with an optimal body part assessment in 5 score had the highest lifespan – 2842 (UBWD) and 2828 (H) days, while with an increase and decrease in the score for this trait, the number of cows days of life declined.

The difference by the average lifetime between cows estimated in 5 score compared to the group of animals assessed at 9 score was 354 (UBWD;  $P<0.01$ ) and 363 (H;  $P<0.01$ ) days. When comparing groups of animals assessed in 5 and 1 score, a reliable difference was revealed, which amounted to 388 (UBWD;  $P<0.001$ ) and 412 (H;  $P<0.001$ ) days.

The functional value of the linear trait of the conformation "rump width", which was estimated by the distance between the caudal protrusions of the ischial hills. In the system of linear classification of dairy cattle, is that a wide rump provides a larger area for udder attachment, a large capacity of the pelvic cavity, widen the birth canal contributing to an easier course of calving of the cow. Separate studies prove that the good rear development of cows in width affects the similar formation of udder morphological traits [3, 6, 12, 17, 18]. Confirming this fact with high correlation coefficients between the udder girth and width at the hooks in Simmental x Holstein 5/8-blood ( $r=0.526$ ) and 3/4-blood ( $r=0.608$ ) hybrids [12], between the rump length and the udder length ( $r=0.17$ ), as well as between the rump and udder bottom slope ( $r=0.13$ ) [6]. Between the rear length and the udder length F.L. Garkavyi [3] also found a highly reliable positive correlation ( $r=0.49$ ). On this occasion, the author believed that both a large and a small udder can be accommodated under a long and wide pelvis, and only a small udder under the small pelvis. According to the following research data [2, 18], the ischial humps width is positively correlated with the udder girth with a variability of 0.134–0.303 depending on the farm, length ( $r=0.141$ –0.351)

and width ( $r=0.161$ –0.417) and the length of the udder front part ( $r=0.111$ –0.302). There is a study proves that the rump width provides the strength of the cow's spine [1].

The indicators of the histogram (Fig. 5) show that the lifetime of cows also depends on the assessment level for the rump width. UBW cows with the highest assessment for this body part development of 9 score were used for 592 ( $P<0.001$ ), and Holstein cows for 708 ( $P<0.001$ ) days longer compared to animals with an assessment in 1 score.

Among the estimated herd of experimental breeds, a significant number of cows ( $n=183$  and 205) were assessed for the rump width at 6 to 9 score, that is, the predominant amount of cows or 65.8 and 70.0% are under the development of quite important in the breeding relationship type trait above than average indicator.

The linear trait of body condition of dairy cows was assessed visually by the thickness of the fat coating in places above the tail root and the pelvis. The assessment degree of the cow for the trait of body condition indicated the amount of fat reserves in the animal's body. The value of the assessment will rise with an increase in fat influx and, conversely, will decrease when the cow is exhausted. The authors of scientific studies [27] reported that fatness often negatively correlated with other descriptive traits as well as with productivity. By the research of Swiss Holstein cows [35], body condition was negatively correlated with chest width trait ( $r=-0.39$ ), dairy forms ( $r=-0.35$ ), udder quality ( $r=-0.42$ ) and milk production ( $r=-0.17$ ). As reported by the Italian Holstein Association [28], body condition was quite closely negatively correlated with angularity ( $r=-0.612$ ) and milk yield per lactation ( $r=-0.386$ ), indicating that high-yielding cows tend to lose weight. However, cows that were classified as thin were better in terms of longevity, as reported in research on Holstein cattle in the Czech Republic [40].

The study's results of cows of the Ukrainian Black-and-White dairy and Holstein breeds, presented in the histogram (Fig. 6), are consistent with the results obtained [9]. Which indicate that the highest degree of body condition score was negatively related to the lifetime of cows in the experimental herd, then as animals with a lower score for the same trait, on the contrary, live and are used much longer. In our research, the highest average lifespan of animals with body condition score of 5 was on average 2842 (UBWD) and 2774 (H) days, respectively. The interbreeding difference on 53–84 days in favor of the UBW animals was not reliable.

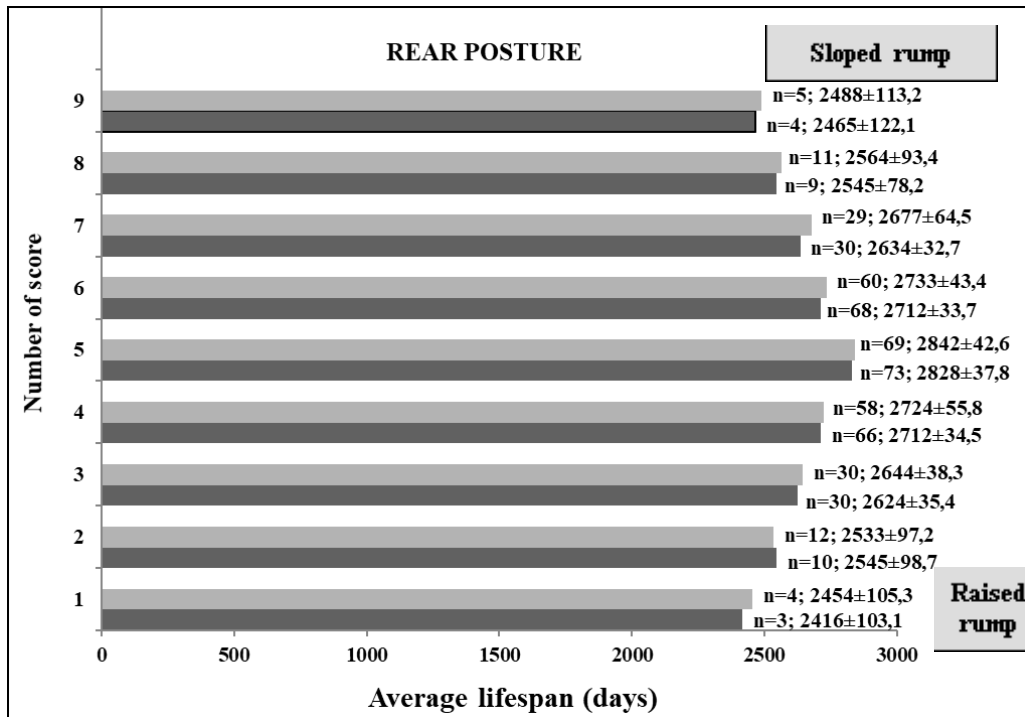


Fig. 4. Correlative variability of the score assessment for descriptive type trait "rear posture" and lifespan of cows in controlled breeds.

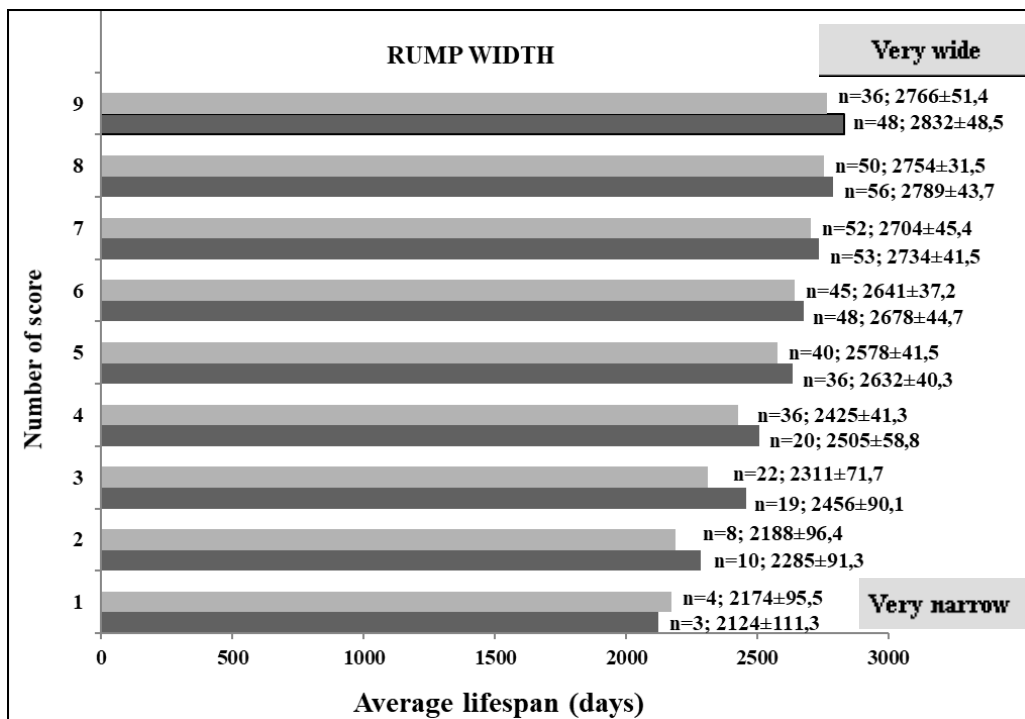


Fig. 5. Correlative variability of the score assessment for descriptive type trait "rump width" and lifespan of cows in controlled breeds.

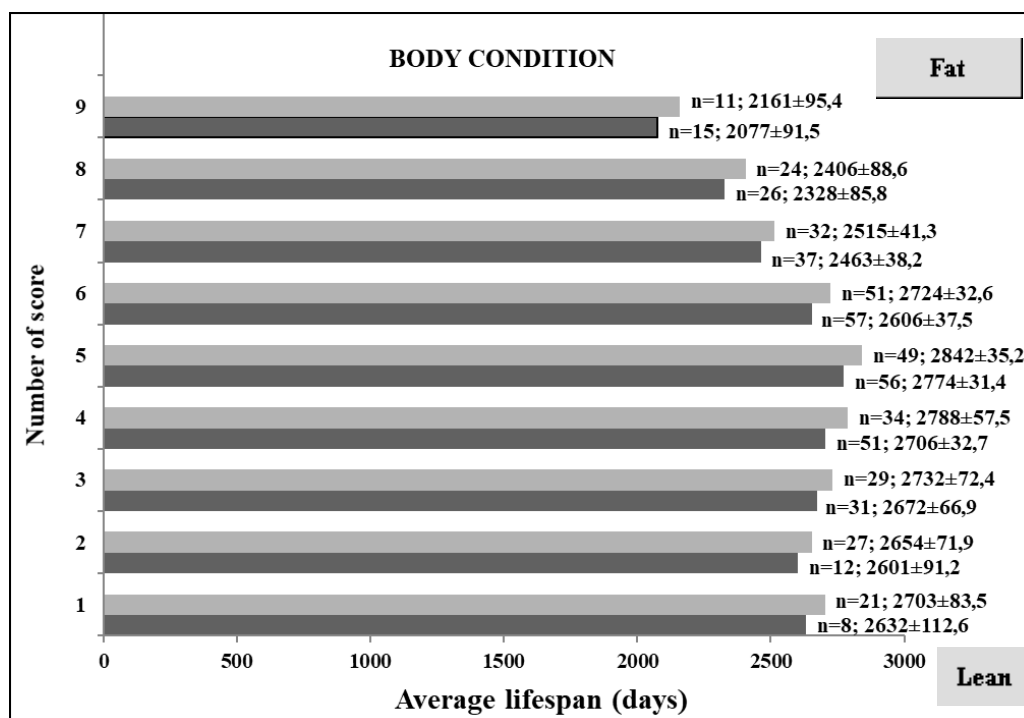


Fig. 6. Correlative variability of the score assessment for descriptive type trait "body condition" and lifespan of cows in controlled breeds.

UBWD cows with an assessment of the body condition in 5 score were used in the herd for 118 days longer compared to animals assessed at 6 score ( $P < 0.05$ ), while the lifetime of cows with 5 score compared to groups of animals, estimated at 7-9 score, was significantly higher by 327–681 days ( $P < 0.001$ ). Lifetime of Holstein cows in the control herd with an assessment of 5 score was significantly higher compared to groups of animals estimated by higher scores, from 168 days (6 score) to 697 days (9 score) ( $P < 0.001$ ). Sufficient lifespan of cows with estimates from 4 to 1 score with variability of 2788–2703 (UBWD) and 2706–2632 (H) days was within the limits of an unreliable difference of 85 and 74 days, respectively.

Summarizing the research results, it can be noted that each of the estimated descriptive traits in cows of both breeds had an impact on lifetime with different variability within each specific body part.

**Conclusions.** 1. The correlative variability of the score assessment of the descriptive traits of the type and lifetime in a comparative analysis of Ukrainian Black-and-White dairy and Holstein cows was established.

2. The degree of correlative variability between the level of assessment of these traits and

the lifetime of animals depended on a specific linear trait.

3. Selection of breeding bulls with a high rating of their daughters by type will ensure an increase in the lifetime of the cows in the herd.

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**Лінійні ознаки типу, які характеризують розвиток тулуба - предиктори довголіття корів української чорно-рябої молочної та голштинської порід**

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Дослідження проведені в аспекті вивчення проблеми щодо тривалості життя корів молочної худоби, залежно від оцінки лінійних ознак екстер'єрного типу. Оцінено за методикою лінійної класифікації корів-первісток українських чорно-рябої молочної (УЧМП) та голштинської (Г) порід. Досліджували описові ознаки екстер'єру, які характеризують загальну будову тіла: ширину грудей, глибину тулуба, кутастість, вгодованість, положення і ширину заду. Встановлено співвідносну мінливість бальної оцінки описових ознак типу з тривалістю життя корів. Співвідносна мінливість ширини грудей і тривалості життя корів має криволінійний характер. Корови з оцінкою за ширину грудей у 4–7 балів вирізнялися вищою тривалістю життя з мінливістю 2704–2844 (УЧРМ) та 2688–2789 (Г) днів. Найвищі терміни тривалості життя були притаманні тваринам з оцінкою за розвиток глибини тулуба у 6–9 балів за недостовірного переважання корів української чорно-рябої молочної породи з найвищими показниками обох порід 2824 (УЧРМ) і 2802 (Г) днів та оцінкою дев'ять балів. Тварини з оптимальною оцінкою кутастості у п'ять балів жили найдовше – 2842 (УЧРМ) та 2828 (Г) днів, тимчасом із підвищенням та зниженням оцінки кількість днів життя корів скорочувалася. За оцінкою ширини заду тривалість життя була найвищою у корів з оцінкою дев'ять балів – 2766 днів УЧРМ та 2832 дні Г. Корови УЧРМ з найвищою оцінкою за розвиток цієї статі у 9 балів використовувалися на 592 (P<0,001), а голштинської – на 708 (P<0,001) днів довше порівняно з тваринами з оцінкою в один бал. Найвища тривалість життя тварин з середньою оцінкою за вгодованість у п'ять балів становить 2842 (УЧРМ) та 2774 (Г) днів. Корови з оцінкою за вгодованість, нижчою за середню, живуть і використовуються у стаді значно довше, ніж з вищою. Ступінь мінливості зв'язку між оцінкою цих ознак та тривалістю життя тварин залежала від конкретної статі будови тіла.

**Ключові слова:** українська чорно-ряба молочна порода, голштинська, лінійні ознаки типу, тривалість життя.



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